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The association between driving anger and driving outcomes: A meta-analysis of evidence from the past twenty years

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ABSTRACT

Through the use of meta-analysis, this study investigated the relationships between driving anger and five types of driving outcomes (aggressive driving, risky driving, driving errors, near misses and accidents). The moderating effects of three variables (age, study publication year, and participants' country of origin) on these relationships were also examined. A total of 51 studies published over the past two decades met the inclusion criteria for the meta-analysis. The results showed that driving anger significantly predicted all three types of aberrant driving, with zero-order correlations of 0.312, 0.243, and 0.179 with aggressive driving, risky driving and driving errors, respectively. The correlations between driving anger and accident-related conditions, though at relatively weaker levels, were still statistically significant. Tests for effects of the moderating variables suggested that driving anger was a stronger predictor of risky driving among young drivers than among old drivers. Also, the anger–aggression association was found to decrease over time and vary across countries. The implications of the results and the directions for future research are discussed.

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1. Introduction

Anger is a strong emotion associated with belligerence and negative feelings towards the cause of the anger and generally accompanied by muscular tension and arousal of the autonomic nervous system (Hambleton et al., 2004). It typically occurs in response to an actual or perceived threat, a disruption in ongoing behavior or in response to the perception of deliberate harm (Averill, 1983; Kring, 2000). Anger has been found to be more frequently experienced in the context of driving than in non-driving situations (Parkinson, 2001). A number of features of the road situation can account for this escalating anger behind the wheel. One problem can be communication between road users, which makes it difficult for a driver to accurately convey and for a target recipient to correctly interpret the message (Parkinson, 2001). Another problem is that social sanctions against anger are lower on the road due to the anonymity of the drivers behind the physical barrier provided by the vehicles (Ellison-Potter et al., 2001). In addition, situational factors such as time pressure and traffic congestion have contributed to an increased anger experiences while driving (Deffenbacher et al., 1994).

What makes driving anger a serious public problem is that in many cases, if not all cases, it can promote aberrant driving (Dahlen et al., 2005; Deffenbacher et al., 2001; Lajunen et al., 1998). Aberrant driving behaviors can contribute to road accidents, resulting in significant injuries, fatalities, and related costs (de Winter and Dodou, 2010; Iversen and Rundmo, 2002; Paleti et al., 2010). It has been estimated that aberrant driving behaviors such as speeding and running red lights accounted for approximately 56% of fatal crashes from 2003 through 2007 in the U.S. (AAA Foundation for Traffic Safety, 2009). In China, the situation is even worse, where approximately 94% of road accidents (Qu et al., 2014) and 95% of all traffic deaths (China Road Traffic Accidents Statistics (CRTAS), 2011) were associated with unsafe behaviors such as racing, tailgating, illegal overtaking and seeking confrontations with other drivers. In transportation literature (de Winter and Dodou, 2010; Richer and Bergeron, 2012), it has been theorized that aberrant driving includes at least three types of road behaviors (i.e. aggressive driving, risky driving, and driving errors) that may threaten road safety.

Although accurate and consistent definitions are lacking, it is generally accepted that both aggressive and risky driving are deliberate behaviors that may endanger the safety of both the driver and other road users. They differ in whether harmful intent towards others is involved in the behaviors. According to Lajunen et al. (1998, p. 108), aggressive driving refers to "*any form of driving behavior that is intended to injure or harm other road users*

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physically or psychologically". By this definition, behaviors such as flashing lights, honking the horn, yelling at another driver or giving obscene gestures all belong to aggressive driving category. More extreme aggressive forms, such as car ramming and physical attacks, although less common on the road, can also happen when drivers become enraged. Risky driving, by contrast, involves exclusively selfish motives such as sensation-seeking or time urgency that are not intended to harm another person (Dula and Geller, 2003; Richer and Bergeron, 2012). Typical risky driving behaviors include speeding, red light running, tailgating, frequent lane changing, racing, drunk driving, and phoning while driving (Bachoo et al., 2013; Dahlen and White, 2006; Richer and Bergeron, 2012). A variety of other behaviors such as not wearing a seatbelt, eating while driving, using a non-motor lane and so on have also been identified by previous studies as risky behaviors on the road (Dahlen et al., 2005; Lucidi et al., 2010; Sullman and Taylor, 2010). Aberrant driving also encompasses the concept of driving errors, which differ from aggressive and risky driving in that they are not deliberate deviations from safe rules and procedures, but rather are unsafe behaviors due to driver misjudgments or failures of observation. Examples of driving errors can be braking too quickly on a slippery road, failing to notice pedestrians crossing the road, or forgetting to check the rear-view mirror before making a turn.

The relationships between driving anger and aberrant driving have been widely investigated, especially after the development of the Driving Anger Scale (DAS) by Deffenbacher et al. (1994) using a sample of US drivers. The DAS was designed to measure trait driving anger, a propensity of drivers to become angry while driving. Initially, two versions, the long version containing 33 questions and the short version containing 14 questions, were proposed. In subsequent applications, some modifications were made when DAS was applied to drivers from specific countries. For example, the 21-item DAS was used for UK drivers (Lajunen et al., 1998) and the 22-item version was used for French drivers (Villieux and Delhomme, 2007). Almost all the relevant research has reported a positive correlation (expressed in terms of correlation coefficient, r) between anger and aggressive driving. However, partially due to the inconsistency in measurement scales used to assess the two terms, the strength of the identified correlations varied considerably across studies. For example, using Cohen's (1988) convention to interpret correlation coefficients as strong ($r \geq 0.5$), moderate ($0.3 \leq r < 0.5$) or weak ($r < 0.3$), Vallières et al. (2014) found a strong relationship ($r = 0.69$), Dahlen et al. (2005) reported a moderate relationship ($r = 0.42$), while Blankenship et al. (2013) only identified a weak relationship ($r = 0.25$), between driving anger and driving aggression. Similarly, the extent to which driving anger can predict risky driving is not clear cut. Both significantly positive (e.g. Oltedal and Rundmo, 2006; Sullman, 2015) and non-significant relations (e.g. Jovanović et al., 2011) have been reported in the literature. The relations between driving anger and errors have been less intensively studied and available studies suggested a positive correlation between them (Berdoulat et al., 2013; Lucidi et al., 2010; Maxwell et al., 2005).

Meta-analysis is a useful technique for combining the results of many previous relevant studies and for exploring the sources of disagreement between their results. A meta-analysis can synthesize findings from multiple studies to produce a weighted average result. By combining the results of available studies, meta-analysis has more power to detect small but significant effects (Sutton et al., 2000). In addition, the estimation of the size of an effect can be improved because when compared with individual studies, meta-analysis is based on much more information extracted from the results of many studies (Borenstein et al., 2011; Zhang and Chan, 2014).

One previous meta-analysis of driving anger and aggressive driving was conducted by Nesbit et al. (2007) by reviewing 18 articles published from 1994 to 2004. The results of the meta-analysis revealed an average correlation of 0.37 between driving anger and aggressive driving, suggesting that these two were moderately and positively associated. However, not all the 18 reviewed studies were concerned specifically with driving anger. Some measured other constructs such as driver stress (e.g. Matthews et al., 1997) or attitude towards driving violations (e.g. Underwood et al., 1997), and therefore, including them in the meta-analysis may have been confounded with the effects of driving anger. Also, significant heterogeneity in the anger–aggression correlation was identified in that study. Nesbit et al. (2007) examined the reasons for the heterogeneity and indicated that the wide variety of the aggression measurement methods (self-report questionnaire, driving log, or driving simulator) partially accounted for it. Unfortunately, additional sources for the heterogeneity were not further investigated in that study. Given that in Nesbit's study, risky driving behaviors such as running a red light were also counted as aggressive driving, it is highly possible that the combination of different types of aberrant driving behaviors contributed to the heterogeneity. Another limitation of this earlier meta-analysis work was that the issue of publication bias was not addressed. Publication bias refers to the phenomenon that research findings are less likely to be published when they are not statistically significant, they are against the previously published materials, or are hard to explain. Publication bias in the study by Nesbit et al. (2007) might have resulted in an upwardly biased estimate of the anger–aggressive driving relationship. Therefore, for more accurate estimates, there is a need to conduct further studies using meta-analysis that only reviews studies focused on driving anger. Moreover, the meta-analysis should be performed for each driving outcome, and be adjusted for publication bias.

There has been great interest in research into driving anger since the work of Nesbit et al. (2007), providing an adequate foundation for further quantitative review of its adverse effects on driving. In addition to a more precise estimation on the size of the effect of driving anger, a large number of available studies also offer an opportunity for a thorough examination of potential moderators. For example, the greater time span covered by the available studies since the previous meta-analysis work makes it possible now to investigate how the anger–aggression correlation changes over time. Such analysis can serve to inform researchers and policy makers about whether intervention strategies aimed at reducing the adverse effects of driving anger are effective or not. Moreover, by testing how personal factors, such as age and gender, can moderate the associations, it is now possible to explore whether the impact of driving anger would reveal individual differences. Identification of the driver group or groups that are most severely affected by driving anger, would allow intervention strategies to be aimed initially at these drivers.

Many studies on driving anger and its impact on driving have been conducted in the twenty years following the development of DAS, yet, a synthesis of the available results is still lacking. This study aimed to perform a quantitative review of the effects of driving anger on different types of driving outcomes using the meta-analysis technique. It should be noted that this review focused exclusively on driving anger. Apart from the frequently studied trait driving anger, which is the tendency of drivers to become angry while driving, studies on situational (state) driving anger, which is a current temporary level of anger experienced during driving as opposed to the more continuous trait anger, were also examined for this review. However, research that only explored the effect of general anger on driving was excluded. This was because, although driving anger and general anger are moderately correlated, they are fairly independent anger constructs and have different impacts on driving (Deffenbacher et al., 2001, 2002). Five types of driving outcomes, including three aberrant driving

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